

Who Will Help Me Harvest the Wheat?

Combines and Careers in Ag Mechanics

Grades: 6–12

Purpose

Students will read about the development and operation of a combine harvester and learn about careers in agricultural mechanics. Students will build a model of a Archimedes' screw, analyze design flaws and improve on the design.

Keywords

wheat, harvest, careers, technology, electronics, mechanics, engineering, inventions, machines, farm equipment, tools past and present

Materials

- Diagram of a combine, provided with this lesson
- Archimedes' Screw Lab Instruction Sheet
- Reading page (Essay): "Combine Harvester: Innovating Modern Wheat Farming, Impacting the Way the World Thinks About Bread"
- "Careers in Wheat Harvest Mechanics" worksheet

Interest Approach or Motivator

Ask students to list modern machines that combines more than one task. What modern machines are used for more than one task (smart phones, computers)? Imagine a time when there was a separate machine for each task. Ask students if they have ever invented anything or wished they could invent something to combine more than one task. Make a list of the proposed inventions on the board.

Background

From the early 1900s to the mid 1920s, the wheat fields of the middle West and Great Plains were scenes of great movement. Only a few workers were needed to plant the wheat crop, using horse and plow, but large numbers of workers were needed for the harvest, because most of the work was done by hand or using hand tools. To do this work as many as 250,000 men were annually on the move from field to field, following the ripening crop.

The need for workers depended on the type of machinery used. Smaller wheat farms used binders, which cut the unripened wheat and bound it into shocks. This required only two to four men—called "shockers"—to follow the machine, collect the bundles, and turn them upside down to ripen. The work was slow, because the binder could only harvest about 10-12 acres a day.



Workers picking up shocks of wheat.

Larger farms used machines called "headers." The header only cut the heads of ripened grain and did not bind them. Because ripe grain could shatter and scatter its seeds, the workers had to harvest the crop as quickly as possible after it ripened. Header operations required a large number of men working intensively over a period of a few days. Header crews included men who drove the horse-drawn headers, men who drove wagons called "barges" that transported the harvested grain, and laborers who arranged the wheat in the wagons for transport and in "ricks" for storage. Headers could cut about 30 acres a day, which meant the workers were on each farm for about one week before moving on to the next one.

After wheat stalks were cut from the field, they had to be threshed to separate the grain from the rest of the

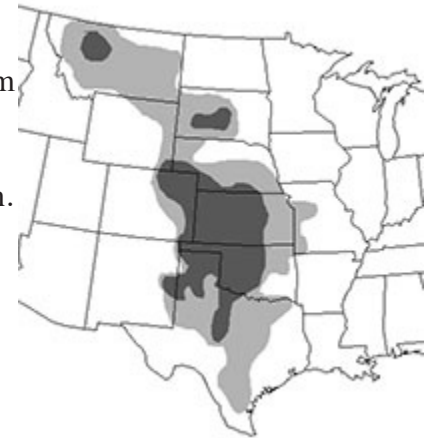
plant. The cutting and threshing took place in two separate operations. Beginning in 1836 the idea of combining the two resulted in various inventions. Early versions of the combined reaper and harvester were quite large and were pulled by horse, ox or mule team, using a bullwheel to provide power. Later, steam power was used, with straw heating the boiler.

Tractor-drawn combines became common after World War II. Early tractor-drawn combines were usually powered by a separate gasoline engine, while later models took power from a separate power source, such as a running engine. These machines either put the harvested crop into bags that were then loaded onto a wagon or truck, or had a small bin that stored the grain until it was transferred to a truck or wagon with an auger.

Various forms were invented and used in different parts of the country, but use of the combine harvester was not widespread across the US until the 1930s. The combine harvester displaced the binder, hand shocking, pitching and threshing. In one operation, the grain was cut and threshed, the cleaned grain elevated into a storage tank and the straw scattered on the field to be plowed under for humus. Mechanization of the wheat harvest reduced significantly the number of laborers needed for harvesting the wheat crop. With the combine, five men could do the work formerly done by 320.

The most recent versions of the combine harvester are self-propelled, with enclosed, heated and air conditioned cabs, radios and Global Positioning System (GPS) technology. They have cushioned seats and adjustable steering wheel heights for leg comfort. With the mechanization of the process, what was once accomplished by hundreds of men can now be done with the flip of a switch.

The combine is the most important piece of equipment for harvesting wheat, but it is an expensive piece of equipment. A new combine can cost over \$300,000. For that reason, many wheat farmers today hire custom operators who invest in the machinery and travel with their own crews during the harvest period. Custom operations today follow much the same migration as that followed by workers in the early part of the last century. Some operations are strictly family operations, with the entire household going on the road during harvest season. Others involve the hiring of crews to operate the equipment and keep it in working order. Cooks go along to provide meals for the workers.



US Wheat Belt, with heaviest production area shaded dark.

Procedures

ACTIVITY ONE

1. Hand out copies of the diagram of a combine, included with this lesson, or project the page onto a whiteboard. Read and discuss background and vocabulary, including the description of combine operations shown in the diagram.
2. Hand out copies of the reading page. Students will read the essay and answer the discussion questions in writing. Students will discuss their answers in groups or as a class.

ACTIVITY TWO

1. An Archimedes' screw, or auger, moves grain from the threshing drum to a tank and then is used again to move the grain out of the combine into a waiting truck or chaser bin. Share the information included with this lesson about the Archimedes' screw. What other common machines use the Archimedes' screw?
2. Students will work in pairs and follow the directions to make their own models of the Archimedes' screw.
3. Students will keep notes as they conduct the experiment and record any problems and other reactions.
4. Students will analyze flaws in the design and discuss possible improvements— using different materials, etc.
5. Students will repeat the experiment and try out their ideas for improvement.
6. Groups will demonstrate their improved designs to the class.

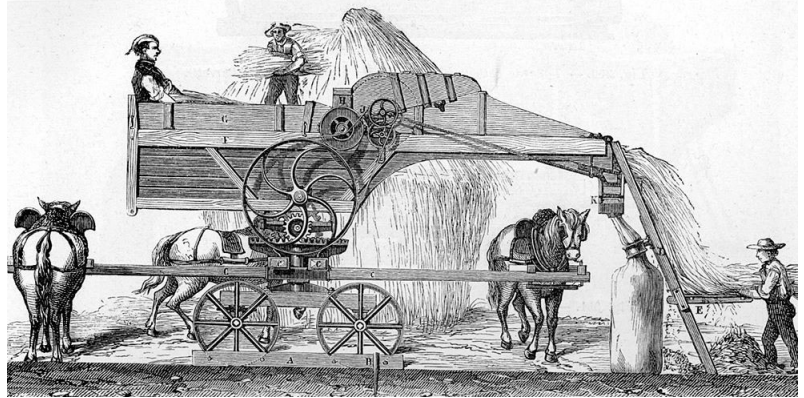
7. Students will discuss the improved designs.

ACTIVITY THREE

1. Hand out the worksheet about careers in agricultural mechanics, included with this lesson.
2. Read and discuss the introductory section.
3. Students will use online search engines to find jobs available in this field.
4. Students will report back and discuss the job possibilities: general education requirements, salary range, public or private, location of jobs, etc.

Enriching Activity

1. The bullwheel (or bull wheel) began use in farm implements with the reaper. The term was commonly used to describe the traveling wheel, traction wheel, drive wheel, or harvester wheel. The bullwheel powered all the moving parts of these farm machines including the reciprocating knives, reel, rake, and self binder. Some examples of common machines powered by a bullwheel include a ski chair lift, the spinning wheel and the bicycle (chain).
2. Students will research the bullwheel and design their own machines, using the bullwheel to power other parts. ()



Thresher powered by a bullwheel and horses

Vocabulary

agriculture— the science or occupation of cultivating the soil, producing crops, and raising livestock

auger— any of various tools made like a spiral or screw and used for boring holes or moving loose material

awn— a bristlelike appendage of a plant, as those forming the beard of wheat

binder— an attachment to a harvester or reaper for binding the cut grain

bullwheel—a large wheel on which a rope turns. The bullwheel began use in farm implements with the reaper. The term was commonly used to describe the traveling wheel, traction wheel, drive wheel, or harvester wheel. The bullwheel powered all the moving parts of these farm machines including the reciprocating knives, reel, rake, and self binder. The bull wheel's outer surface provided traction against the ground and turned when the draft animals or tractor pulled the implement forward.

career— a profession followed as a permanent occupation

chaff— the husks of grains and grasses that are separated during threshing

chute— an inclined channel, as a trough, tube, or shaft, for conveying water, grain, coal, etc., to a lower level

combine— a machine that harvests, threshes, and cleans grain while moving over a field

concave— a shaped "half drum," also fitted with steel bars and a meshed grill, through which grain, chaff and smaller debris may fall

custom— made specially for individual customers

draper— a fabric or rubber apron used instead of a cross auger on a wheat header. Draper headers allow faster feeding than cross augers.

Global Positioning System (GPS)— a navigational system using satellite signals to fix the location of a radio receiver on or above the earth's surface

grain— the seeds of plants (such as wheat, corn, and rice) that are used for food

harvest— the season when crops are gathered from the fields or the activity of gathering crops

header— a grain-harvesting machine that cuts off the grain heads and elevates them to a wagon

helical— spiral

helicoid— forming or arranged in a spiral

hydrostatic— relating to or denoting the equilibrium of liquids and the pressure exerted by liquid at rest. Hydrostatics is fundamental to hydraulics, the engineering of equipment for storing, transporting and using fluids. In fluid power, hydraulics are used for the generation, control, and transmission of power by the use of pressurized liquids.

humus— a brown or black material in soil that is formed when plants and animals decay

innovation— a new idea, device, or method

kernel— a whole seed of a cereal

rasp bar— a metal bar with sharp points that separates the grain from the rest of the plant on a combine harvester

reel— a device that can be turned round and round to wind up something flexible

rick— a stack (as of hay) in the open air

shaft— a bar in a machine which holds or turns other parts that move or spin

shock— a pile of sheaves of grain or stalks of Indian corn set up in a field with the butt ends down

shoe— the part of a harvester or combine which both sieves out large impurities such as rocks and blows out light impurities such as chaff

sickle— an agricultural implement consisting of a curved metal blade with a short handle fitted on a tang

sieve— a device with meshes or perforations through which smaller particles may be passed to separate them from coarser ones

stabilize— to make or become unlikely to change suddenly or greatly

tailings— residue separated in the preparation of various products (as grain or ores)

thresh— to separate the seeds of corn, wheat, etc., from the plant by using a special machine or tool

variable— something that changes or that can be changed : something that varies

winnow— blowing a current of air through (grain) in order to remove the chaff

windrow— a row of cut vegetation (as grain) raked up to dry before being baled or stored

Combine Harvester Facts

- The combine harvester, or simply combine, is a machine that harvests grain crops. The name derives from its combining three separate operations comprising harvesting—reaping, threshing, and winnowing—into a single process.
- Among the crops harvested with a combine are wheat, oats, rye, barley, corn (maize), sorghum, soybeans, flax (linseed), sunflowers, peas, beans, lentils and canola.
- The combine was invented in the United States by Hiram Moore in 1834.
- Early versions of the combine harvester were pulled by horse, mule teams or oxen.
- George Stockton Berry integrated the combine with a steam engine using straw to heat the boiler.
- Tractor-drawn combines became common after World War II.
- In 1911, the Holt Manufacturing Company of California produced a self-propelled harvester. In Australia in 1923, the patented Sunshine Auto Header was one of the first center-feeding self-propelled harvesters. In 1923 in Kansas, the Baldwin brothers and their Gleaner Manufacturing Company patented a self-propelled harvester which included several other modern improvements in grain handling.
- The combine harvester is one of the most economically-important labor saving inventions, significantly reducing the fraction of the population that must be engaged in agriculture.
- Most, if not all, modern combines are equipped with hydrostatic drives. These are larger versions of the same system used in consumer and commercial lawn mowers that most are familiar with today. In fact, it was the downsizing of the combine drive system that placed these drive systems into mowers and other machines.
- Grain combine fires are responsible for millions of dollars of loss each year. Fires usually start near the engine where dust and dry crop debris accumulate. Fires can also start when heat is introduced by bearings or gearboxes that have failed. From 1984 to 2000, 695 major grain combine fires were reported to U.S. local fire departments.

Standards

National Ag Literacy

3. Food, Health and Lifestyle

- Identify sources of agricultural products that provide food, fuel, clothing, shelter, medical, and other non-food products for their community, state, and/or nation
- Identify the careers in food production, processing, and nutrition that are essential for a healthy food supply

4. Science, Technology, Engineering and Mathematics

- Identify specific technologies that have reduced labor in agriculture
- Discuss how technology has changed over time to help farmers/ranchers provide more food to more people
- Compare and contrast historical and current food processing and systems
- Provide examples of science and technology used in agricultural systems (e.g., GPS, artificial insemination, biotechnology, soil testing, ethanol production, etc.); explain how they meet our basic needs; and detail their social, economic, and environmental impacts.
- Identify science careers related to both producers and consumers of agricultural products
- Correlate historical events, discoveries in science, and technological innovations in agriculture with day-to-day life in various time periods
- Identify current and emerging scientific discoveries and technologies and their possible use in agricultural systems (e.g., biotechnology)
- Predict the types of careers and skills agricultural scientists will need in the future to support agricultural production and meet the needs of a growing population

5. Culture, Society, Economy & Geography

- Discuss how agricultural practices have increased agricultural production and have impacted (pro and con) the development of the global economy, population and sustainability
- Describe essential agricultural careers related to production, consumption, and regulation
- Evaluate and discuss the impact of major agricultural events and agricultural inventions that influenced world and U.S. history

Content Standards

Science—MS-PS2,3; MS-ETS1; HS-PS2,3; HS-ETS1

Economics—D2.1.6-8; 13.6-8; D2.1.9-12; 13.6-8

History—D2.1,2,3.6-8; D2.1,2,3.9-12; D3.1,2,3,4.6-8; D3.1,2,3,4.9-12

Common Core

ELA—RI.1,3,4,5,8,10; W.1,2,10; SL.1,2,4,5

Resources

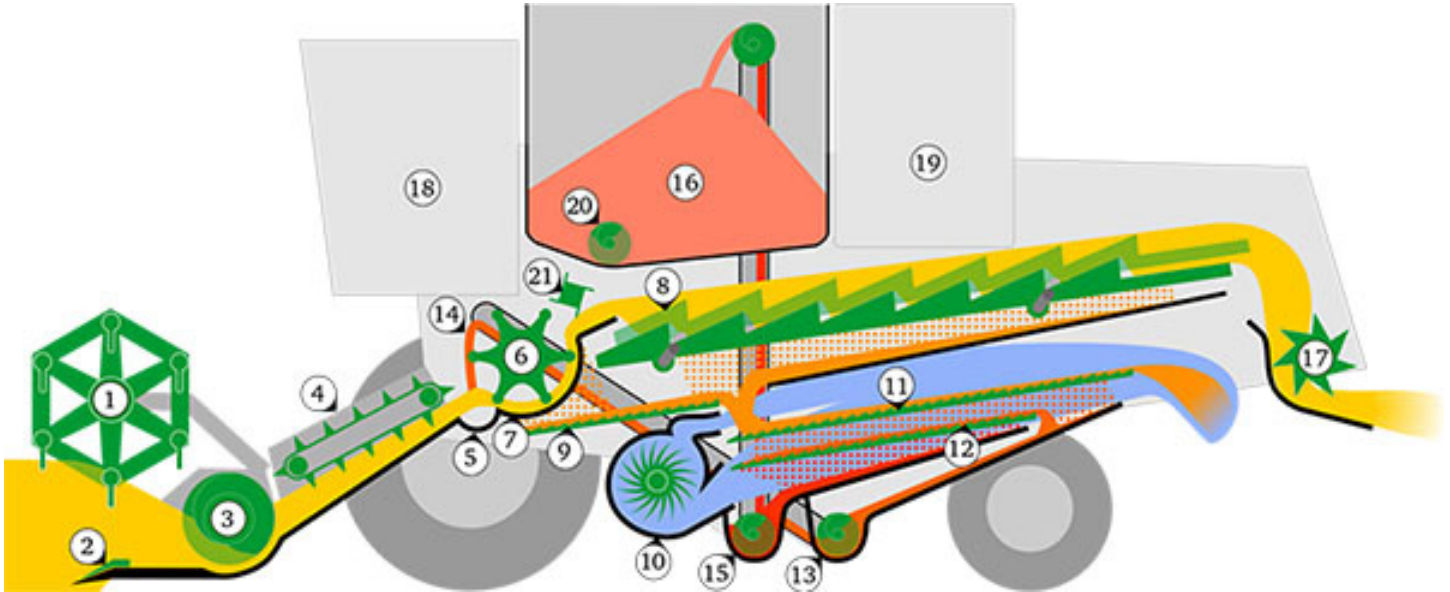
- “Historical Timeline: Farm Machinery and Technology,” *Growing a Nation—The Story of American Agriculture*, https://www.agclassroom.org/gan/timeline/farm_tech.htm
- A Look Inside A Modern Combine Harvester: <https://www.youtube.com/watch?v=KwQKKaZzrK4>
- Wheat Harvest USA, 1947: <https://www.youtube.com/watch?v=82TL8ocQKcI>
- “Horse-Drawn Reaper Binder, Victorian Farm:” <https://www.youtube.com/watch?v=vidzddSu0D0>
- Food, Agriculture and Natural Resources Careers, USDA Living Science, <https://www.agriculture.purdue.edu/usda/careers/contactus.html>
- MyCAERT, <http://www.mycart.com/career-profiles/>
- Study.com, http://study.com/article_directory/q_p/page/Agriculture/q_p/Careers_and_Occupations_List.html

- Occupational Outlook Handbook, Bureau of Labor Statistics, US Department of Labor, <http://www.bls.gov/ooh/>
- Agriculture and Forestry Careers: <http://www.environmentalscience.org/careers/agriculture-and-forestry>
- Careers in Agriculture (Georgia Agricultural Education): <http://www.gaaged.org/page.aspx?ID=353>

Source/Credits

- Oklahoma Ag in the Classroom, “Hoboes on Harvest” <http://www.clover.okstate.edu/fourh/aitc/lessons/intermed/hoboes.pdf>
- Taylor, Paul Schuster, “Migratory Farm Labor in the United States,” from *Labor on the Land: Collected Writings 1930-1970*, Ayer, 1981.
- Historylink.org, http://www.historylink.org/index.cfm?DisplayPage=output.cfm&file_id=10222

Conventional Combine Harvester

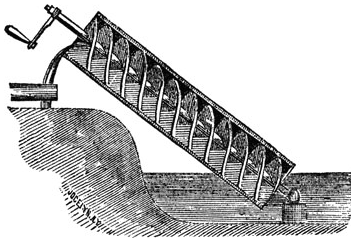


“Maehdrescher schema nummeriert” by Hans Wastlhuber & Tucvbif. Licensed under CC BY-SA 2.5 via Commons - https://commons.wikimedia.org/wiki/File:Maehdrescher_schema_nummeriert.svg#/media/File:Maehdrescher_schema_nummeriert.svg

Conventional combine harvester: 1) reel; 2) cutter bar; 3) header auger; 4) grain conveyor; 5) stone trap; 6) threshing drum; 7) concave; 8) straw walker; 9) grain pan; 10) fan; 11) top adjustable sieve; 12) bottom sieve; 13) tailings conveyor; 14) rethreshing of tailings; 15) grain auger; 16) grain tank; 17) straw chopper; 18) driver's cab; 19) engine; 20) unloading auger; 21) impeller

1. The cut crop is carried up the feeder throat (commonly called the “feederhouse”) by a chain and flight elevator.
2. Then it is fed into the threshing mechanism of the combine, consisting of a rotating threshing drum (commonly called the “cylinder”), to which grooved steel bars (rasp bars) are bolted.
3. The rasp bars thresh or separate the grains and chaff from the straw through the action of the cylinder against the concave, a shaped half drum, also fitted with steel bars and a meshed grill, through which grain, chaff and smaller debris may fall.
4. The straw, being too long, is carried through onto the straw walkers. This action is also allowed due to the fact that the grain is heavier than the straw, which causes it to fall rather than “float” across from the cylinder/concave to the walkers. The drum speed is variably adjustable on most machines, while the distance between the drum and concave is finely adjustable fore, aft and together, to achieve optimum separation and output. Manually engaged disawning plates are usually fitted to the concave. These provide extra friction to remove the awns.
5. After the primary separation at the cylinder, the clean grain falls through the concave and to the shoe, which contains the chaffer and sieves.

Archimedes' Screw



The Archimedes' screw is a machine historically used for transferring water from a low-lying body of water into irrigation ditches. Water is pumped by turning a screw-shaped surface inside a pipe.

The Archimedes screw consists of a screw (a helical surface surrounding a central cylindrical shaft) inside a hollow pipe. The screw is turned usually by a windmill or by manual labour. As the shaft turns, the bottom end scoops up a volume of water. This water is then pushed up the tube by the rotating helicoid until finally it pours

out from the top of the tube.

An auger is essentially an Archimedes' screw. The auger delivers material from one end of a conveyor to the other and is particularly suitable for transport of granular materials such as wheat. On a combine harvester, augers move the grain from the threshing drum to a tank and then move the grain out of the combine into a truck or chaser bin. Follow the directions below to make an auger for moving dry cereal or popcorn.

Materials

2-liter plastic bottle, with lid
cardstock
scissors
craft dowel, about 12 inches long
strong glue
tack
bowl of dry cereal or popped popcorn

Note: This activity is best conducted over two or three class periods, since it works best to let the glue dry overnight.



1. Cut off the bottom of the bottle and cut a triangle at the top, near the lid, as shown.
2. Use regular or scrap paper to cut a circle to serve as a pattern. The circle needs to fit snugly into the bottle, but not so tight that it won't turn when the screw is assembled. Use the bottom of the bottle to draw the circle and then cut it just slightly smaller.
3. Find and mark the center of the sample circle. Draw a small circle at the center through which the dowel will fit.
4. Cut a straight line from the edge to the center of the circle, and cut a hole at the center the size of the small circle you have drawn.
5. Use the pattern to draw 6-8 circles on the cardstock, including the small circle in the center.
6. Cut a straight line from the edge to the center of each circle and cut holes in the center as marked.
7. Using a good strong glue, glue the slit-edge of one circle to the opposite side of the slit on another circle. As you are gluing, you will see how a "screw" is being formed when you pull it gently from the ends. As much as possible, keep the center holes lined up. Continue gluing all of the disks in this way. Let the glue dry thoroughly.
8. When the glue has dried completely, carefully push the dowel through the center holes. Glue one end, stretch the screw a little, then glue the other end. You may need to use tape to hold the ends in place until the glue dries. Leave enough space at the top to attach to the tack at the top and enough space at the bottom for turning. Let dry.



9. Push a tack through the bottle lid.
10. Assemble. Be sure your glue is completely dry before assembling. Push the dowel/disks gently into the bottle until the top of the dowel is even with the top of the bottle.
11. Screw the bottle cap on, pushing the tack tightly into the dowel. This is your Archimedes' screw, or auger.
12. Holding the dowel, put your auger down into a deep bowl of cereal or popcorn and turn gently to lift the grain.

Try it out. Remember that inventors rarely succeed on their first try. What problems did you encounter? What are some flaws of the design? How can you make it better? Try with other materials, different size bottles, etc. Try moving different kinds of grain through the auger.

Source: <http://kartwheels.org/2015/04/28/archimedes-screw-science-project/>



Combine unloading into chaser bin. The long pipe encloses an auger that lifts the wheat kernels from the combine and deposits them into the chaser bin. The chaser bin then uses another auger to unload the wheat onto a truck for delivery to a grain elevator.



Photo by Cd design85 (Own work) [CC BY-SA 3.0 (<http://creativecommons.org/licenses/by-sa/3.0/>)], via Wikimedia Commons

Combine Harvester

Innovating Modern Wheat Farming, Impacting the Way the World Thinks About Bread

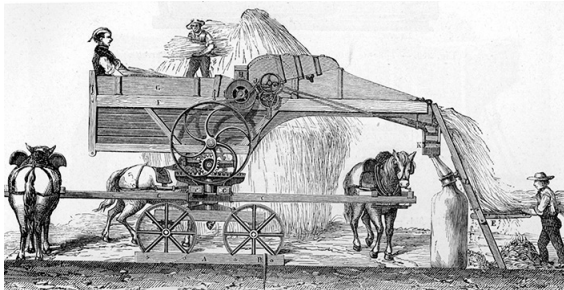
Excerpted from an essay by Christoper Wiley, 2010 Washington State History Day Award Winner, Junior Division, historylink.org

Headers and Threshers

The combine harvester is the most modern harvester of wheat. It's called a combine because it "combines" the job of the header and thresher which were its predecessors. ...The first combine was made by Hiram Moore in 1836 and was ahead of its time (Keith). Change wasn't accepted so it would have to wait till the end of the century for its turn. After it did become the dominant harvesting method, it revolutionized the way the world ran. It was successful because it made farming safer, more profitable, and brought food to many. But through the 1800s, the header and the thresher were king.

The header was pushed through the field by six horses from the back of the machine (Keith). Pushing from the back reduced crop trampling. On the front edge of the header was a row of sharp teeth called sickles (Brumfield). Sliding back and forth in a blur, they touched the wheat stalk first and sliced it. To keep the wheat from falling on the ground, a reel circled around and paddles knocked the wheat into the header (Doty). The height of the header could be changed to keep it out of the dirt, and to make sure all the wheat was cut. Then a draper in the bottom of the header slid to the side of the header like the belt on the checkout counter of a grocery store. The wheat went up a sort of chute, and fell down into a wagon driving alongside the header. This wagon was pulled by four horses (Brumfield). When the wagon was full, the header stopped, the wagon pulled out, another came in, and they started over. All moving parts were turned by the "bull wheel" which was like a gear. The header was 12 feet wide and could cut 30 acres a day (Brumfield).

Wagons then traveled to the thresher which was placed at a central harvest site to reduce distance traveled.



Horse-powered thresher

The thresher was first run by horses walking in circles. Later, steam engines ran the machine (Keith). The wagon was unloaded and wheat was dropped next to the thresher. Here it was pitched inside the thresher (Schillinger). The thresher threshed the wheat until the kernels fell from the head. The kernels, having now been threshed, came back out of the machine in one spot, the straw and chaff came out another (Wiley). The thresher had a crew of six people. The "Separator man" was a talented mechanic who constantly serviced the machine. The "Sack-jig" filled the burlap sacks with grain that

came out a spout (Brumfield). When the sack was full he passed it to one of two "Sack sewers" who sewed the sacks up lightning fast (Sherman). It is estimated that together, they sewed 1000 sacks a day. While the sacks weighed about 140 pounds, sewers tossed sacks 50 feet into a pile like they were weightless (Schillinger/Brumfield/Sherman). Since the thresher didn't move, the straw that came out the back would eventually plug the machine. The "Straw-buck" threw the straw into a small wagon and hauled it away with a team of two horses (Brumfield). Later, a fan blower was added that pushed the straw out and away from the machine. Then the "Straw-buck" didn't have quite as much work. The "Fireman" burned wood to run the boilers. George Stockton Berry came up with the idea of burning straw to heat the boilers which produced the steam. Fires were occasionally started this way. The total harvest crew was about 30 men and 30 horses.

The Combine Harvester

In the early 1900s it was the combine's time. The combine used the same number of people; however it did take up to 40 horses. Thirty to 36 pulled the machine; the rest pulled a wagon that gathered the grain sacks the sack sewers would throw off the machine as they rode along. Imagine that the thresher was the wagon that

drove along the side of the header. Now attach the header to the side of the thresher and add about 30 horses to the thresher. This was the first horse drawn combine (Keith/Doty/Brumfield/Schillinger). Combines could weigh over fifteen tons and the header could be thirty feet wide. The combine could harvest 40 acres a day (Brumfield/Keith). The crew included the separator man, the driver, and the header tender who controlled the header, the sack jig, and two sack sewers. Despite everyone's hard work, harvest crewmen earned only three dollars a day during the early 1900s (Green).



Now that you can compare the combine and thresher, it is plain to see why the combine is considered an innovation. Total harvest crews were now under 10 instead of over 30. This was huge for farmers since most had a tight budget. Besides a lunch break the combine could go all day without stopping. The thresher had to wait for wagons to come back so they didn't dump the wheat on the ground. This saved hours of precious time. The combine could travel faster than a header because the horses pulled instead of pushed (Keith). They walked in front of the thresher portion, the wheat was to the side of them (Doty). The combine could harvest 40 acres a day instead of a couple hundred a season that the thresher could produce (Schillinger). Through 1911-1919, steam was slowly replaced with a gasoline engine which meant farmers didn't need wood or straw to heat the boilers. The combine for some farmers meant bigger crops because they could get all their wheat cut before the rain without going bankrupt hiring men and machinery (Brumfield/Wiley). Like almost everything else, the combine wasn't perfect. Before, it might have been easy to get a job on a threshing crew. With the numbers reduced from 30 or more to five or six, there were some people who might have been out of a job. It is possible that since the demand for machinery grew and the demand for machine shop workers grew with it, people might have found a job here instead.

Improvements

...In 1925, a company called International Harvester from Chicago, Illinois released its first line of tractor pulled combines (Schillinger). Farmers didn't even have to go buy a new combine. It was possible to take the old combine, replace the horse hitch with a tractor hitch, and buy a tractor. Most farmers had a tractor available anyway...Forty horses is a lot to control, feed, and care for. They need complicated hitches to ensure horse safety and comfort, the farmer's safety, and to maximize production (Keith). A tractor doesn't need food or water. A tractor doesn't need 39 companions to work. A tractor doesn't need complicated hitches. All it needs to run all day is fuel, a quart of oil every once in a while, and a few globs of grease here and there (Wiley). The tractor goes faster than the horses as well. There was no question the tractor was the farmer's best friend. However, this did mean horses were no longer needed and some were probably nudged off the farm.

Eventually, a company called Massey Harris from Wisconsin wondered why the combine had to be pulled. Why shouldn't it pull itself? It almost looked like a tractor. Why waste fuel to fill up the tractor's engine and the combine's engine? (By now everything was powered by gasoline or diesel engines.) This innovative thinking led to one of the biggest advancements in wheat farming history. In 1939 Massey Harris solved this problem. They created the Massey Harris Model 21. This will forever be recognized as the first self propelled combine (Schillinger). These combines were small compared to the horse pulled variety. The header was directly in front because the crop wasn't in danger of being trampled. Even though these only harvested around thirty acres a day, farmers could afford three or four combines (Wiley). Despite their lack of size, the self propelled combines were cheaper, more efficient, and a huge improvement in the farming industry. There was only one last problem to solve. Farmers were tired of sacking wheat (Brumfield). The Massey Harris Model 21 was equipped with a grain tank that could bulk hold about 100 bushels of wheat. Then the whole load was dumped at once into the back of a truck bed with the unloading auger. The most skilled drivers didn't even have to stop the combine to unload. The last thing the combine did between here and there was provide a closable cab so the driver could get out of the heat and horrible dust. For years farmers would come home caked with dirt from head to toe. Now they might only be halfway caked with dirt (Wiley)....

The Combine Harvester Today

Today's combines are just as innovative as the Model 21's; however they are much bigger. They harvest anywhere from 100 to 200 acres a day with 34 foot headers and go six or seven mph if necessary (Wiley). They have air conditioning, heaters, headlights, a radio, and the newest can even have a GPS. They have cushioned seats and adjustable steering wheel heights for leg comfort. What was accomplished by yanking a lever can now be done by flicking a switch (Wiley).

Despite today's accommodations, you can see the roots from which the modern day combines emerged. It is plainly obvious why it's considered an innovation. It reduced the crewmen per crew, it traveled faster as it evolved, it doubled and tripled crop production, and it became more efficient countless times. It saved money, became safer, cleaner, and comfortable. It made it much safer for farm animals that ran the machines for many years. It brought food to soldiers overseas in war. It stabilized the grain market and kept the population fed. This is certainly the greatest thing the combine did....

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1. Compare wheat harvest before and after the invention of the combine harvester. What tasks were combined?
2. Why was the combine harvester successful?
3. The author claims the combine harvester "revolutionizes the way the world ran?" Does he support his claim? What does he mean? Do you think that is an exaggeration? Why or why not?
4. Summarize in numbered steps the process described in the header/thresher section.
5. Discuss the ways the combine harvester saved labor and time.
6. Where does the author suggest out of work laborers might have found work instead? What would be required for a laborer to transition to a different kind of work?
7. What replaced teams of horses as the means for powering the combine harvester?
8. What improvement does the author describe as "one of the biggest advancements in wheat farming history?" Why was it so important?
9. What impact do you think the invention of the combine harvester has had on modern wheat production? For the wheat producer? For the consumer? For laborers?
10. New technology under development includes machinery that drives itself, which will decrease the need for labor in the wheat harvest even more. What do these new developments mean for people looking for work in wheat production? How should a person prepare for the new developments?

Careers in Wheat Harvest Mechanics

With the invention of the combine, five men could do the work formerly done by 320. That doesn't mean there are no career opportunities left in the field of combine mechanics. Combines need careful maintenance to avoid damaging the wheat kernels or clogging the machinery. Conditions in the field may change from hour to hour, and failure to adjust can cause losses. There are a large number of bearings that require proper lubrication. Mechanics must keep bolts tight and belts, canvases and chains at the correct tension. Operators must watch for stones and other foreign material and stop the machine before such obstruction causes damage. At the end of the season, all dust and chaff must be cleaned from the inside and outside to keep moisture from gathering which would cause steel parts to rust.

Agricultural mechanics is important in almost every aspect of agriculture and ranges from simple to very complex. Troubleshooting is a daily requirement, so those working in this field must have good problem-solving skills. In addition to maintenance of machinery, careers in agricultural mechanics include selling, designing and maintaining farming equipment. Higher-paying positions generally require a bachelor's degree or above in ag mechanics with courses such as fluid mechanics, design methodology and soil science. Some jobs may require individuals to have a license.

Based on what you have learned about modern wheat harvesting technology, make a list of careers in agricultural mechanics that are the most closely related to changes in harvesting. Use an online search engine to locate five job openings related to the careers you have listed. Use the information you find to fill in the blanks below:

Name of Company_____ Location_____

Job Description:

Job Requirements (Education/Training)

Salary Range